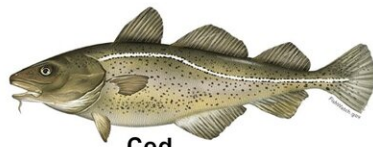


Climate change likely to increase human exposure to toxic methylmercury

August 7 2019

**1°C Increase in Seawater Temperature
+
20% Decrease in Mercury Emissions**



Cod



10 %

Increase in
Methylmercury



Spiny Dogfish



20 %

Increase in
Methylmercury

A 1-degree increase in seawater temperature and a 20-percent decrease in mercury emissions result in increases in methylmercury levels of 10 percent in cod and 20 percent levels in spiny dogfish. Credit: Harvard SEAS

Add another item to the ever-growing list of the dangerous impacts of global climate change: Warming oceans are leading to an increase in the harmful neurotoxicant methylmercury in popular seafood, including cod, Atlantic bluefin tuna and swordfish, according to research led by the

Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Harvard T. H. Chan School of Public Health (HSPH).

Researchers developed a first-of-its-kind, comprehensive model that simulates how [environmental factors](#), including increasing sea temperatures and overfishing, impact levels of [methylmercury](#) in fish. The researchers found that while the regulation of mercury emissions have successfully reduced methylmercury levels in fish, spiking temperatures are driving those levels back up and will play a major role in the methylmercury levels of marine life in the future.

The research is published in *Nature*.

"This research is a major advance in understanding how and why ocean predators, such as tuna and swordfish, are accumulating mercury," said Elsie Sunderland, the Gordon McKay Professor of Environmental Chemistry at SEAS and HSPH, and senior author of the paper.

"Being able to predict the future of mercury levels in fish is the holy grail of mercury research," said Amina Schartup, former research associate at SEAS and HSPH and first author of the paper. "That question has been so difficult to answer because, until now, we didn't have a good understanding of why methylmercury levels were so high in big fish."

It's been long understood that methylmercury, a type of organic mercury, bioaccumulates in [food webs](#), meaning organisms at the top of the food chain have higher levels of methylmercury than those at the bottom. But to understand all the factors that influence the process, you have to understand how fish live.

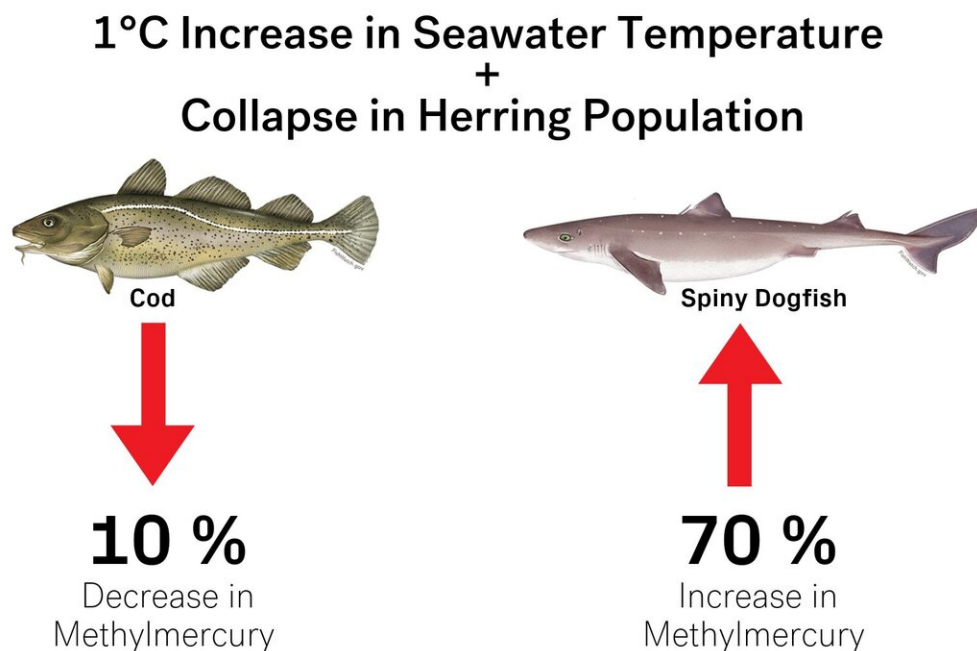
If you've ever owned a goldfish, you know that fish do pretty much two things: eat and swim. What they eat, how much they eat, and how much

they swim all affect how much methylmercury fish will accumulate in the wild.

Let's start with what fish eat.

The researchers collected and analyzed 30 years of ecosystem data from the Gulf of Maine, including an extensive analysis of the stomach contents of two marine predators, Atlantic cod and spiny dogfish from the 1970s to 2000s.

The researchers found that methylmercury levels in cod were 6 to 20 percent lower in 1970 than they were in 2000. Spiny dogfish, however, had levels 33 to 61 percent higher in 1970 compared to 2000 despite living in the same ecosystem and occupying a similar place in the food web. What accounts for these differences?



A 1-degree increase in seawater temperature and a collapse in the herring

population result in a 10-percent decrease in methylmercury levels in cod and a 70-percent increase in spiny dogfish. Credit: Harvard SEAS

In the 1970s, the Gulf of Maine was experiencing a dramatic loss in herring population due to overfishing. Both cod and spiny dogfish eat herring. Without it, each turned to a different substitute. Cod ate other small fish such as shads and sardines, which are low in methylmercury. Spiny dogfish however, substituted herring with higher in methylmercury food such as squid and other cephalopods.

When the herring population bounced back in 2000, cod reverted to a diet higher in methylmercury while spiny dogfish reverted to a diet lower in methylmercury.

There's another factor that impacts what fish eat: mouth size.

Unlike humans, fish can't chew—so most fish can only eat what fits in their mouth whole. However, there are a few exceptions. Swordfish, for example, use their titular bills to knock down large prey so they can eat it without resistance. Cephalopods catch prey with their tentacles and use their sharp beaks to rip off mouthfuls.

"There's always been a problem modeling methylmercury levels in organisms like cephalopods and swordfish because they don't follow typical bioaccumulation patterns based on their size," said Sunderland. "Their unique feeding patterns means they can eat bigger prey, which means they're eating things that have bioaccumulated more methylmercury. We were able to represent that in our model."

But what fish eat isn't the only thing that impacts their methylmercury levels.

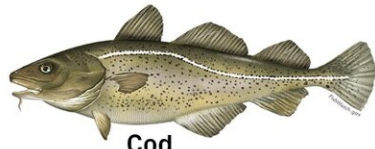
When Schartup was developing the model, she was having trouble accounting for the methylmercury levels in tuna, which are among the highest of all marine fish. Its place on the top of the food web accounts for part of this but doesn't fully explain just how high its levels are. Schartup solved that mystery with inspiration from an unlikely source: swimmer Michael Phelps.

"I was watching the Olympics and the TV commentators were talking about how Michael Phelps consumes 12,000 calories a day during the competition," Schartup remembered. "I thought, that's six times more calories than I consume. If we were fish, he would be exposed to six times more methylmercury than me."

As it turns out, high-speed hunters and migratory fish use a lot more energy than scavengers and other fish, which requires they consume more calories.

"These Michael Phelps-style fish eat a lot more for their size but, because they swim so much, they don't have compensatory growth that dilutes their body burden. So, you can model that as a function," said Schartup.

20% Decrease in Mercury Emissions



Cod



20 %

Decrease in
Methylmercury



Spiny Dogfish



20 %

Decrease in
Methylmercury

A 20-percent decrease in emissions, with no change in seawater temps, decreases methylmercury levels in both cod and spiny dogfish by 20 percent. Credit: Harvard SEAS

Another factor that comes into play is water temperature; as waters get warmer, [fish](#) use more energy to swim, which requires more calories.

The Gulf of Maine is one of the fastest warming bodies of water in the world. The researchers found that between 2012 and 2017, methylmercury levels in Atlantic bluefin tuna increased by 3.5 percent per year despite decreasing emissions of mercury.

Based on their model, the researchers predict that an increase of 1 degree Celsius in seawater temperature relative to the year 2000 would lead to a 32 percent increase in methylmercury levels in cod and a 70-percent increase in spiny dogfish.

The model allows the researchers to simulate different scenarios at once. For example:

A 1-degree increase in seawater temperature and a 20-percent decrease in mercury emissions result in increases in methylmercury levels of 10 percent in cod and 20 percent levels in spiny dogfish.

A 1-degree increase in seawater temperature and a collapse in the herring population result in a 10-percent decrease in methylmercury levels in cod and a 70-percent increase in spiny dogfish.

A 20-percent decrease in emissions, with no change in seawater temps, decreases methylmercury levels in both cod and spiny dogfish by 20 percent.

"This model allows us to look at all these different parameters at the same time, just as it happens in the real world," said Schartup.

"We have shown that the benefits of reducing mercury emissions holds, irrespective of what else is happening in the ecosystem. But if we want to continue the trend of reducing methylmercury exposure in the future, we need a two-pronged approach," said Sunderland. "Climate change is going to exacerbate human exposure to methylmercury through seafood, so to protect ecosystems and human health, we need to regulate both mercury emissions and greenhouse gases."

More information: Climate change and overfishing increase neurotoxicant in marine predators, *Nature* (2019). [DOI: 10.1038/s41586-019-1468-9](https://doi.org/10.1038/s41586-019-1468-9) , www.nature.com/articles/s41586-019-1468-9

Provided by Harvard John A. Paulson School of Engineering and Applied Sciences

Citation: Climate change likely to increase human exposure to toxic methylmercury (2019, August 7) retrieved 23 April 2024 from <https://phys.org/news/2019-08-climate-human-exposure-toxic-methylmercury.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.